A Study on the Methodology of Survey and Analysis of the Scenic Resources on SMART Highways

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Abstract

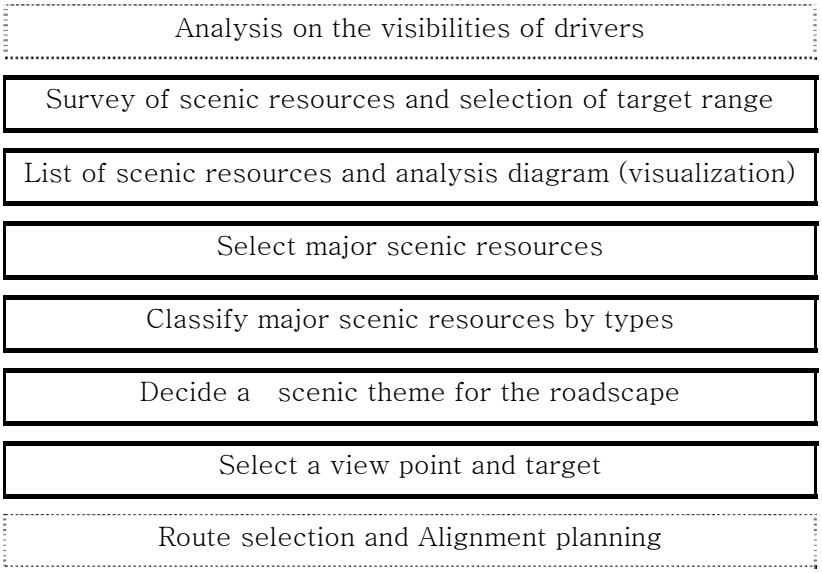
This paper proposes a methodological process, from site survey and analysis to typical classification of roadscape, development of scenic theme, and selection of landscape control point (LCP) and view target, in order to apply a design method which takes the high speed driving and emotional characteristics into consideration in landscape design. In addition, a quantitative evaluation method is suggested to enable to apply landscape design technique in the process of developing the scenic theme, route design and road alignment design for constructing pleasant and safe roads which take drivers' visual-perceptional emotion and driving characteristics into consideration.

1. Introduction

The current road design field, most designers still adhere to the traditional design technologies, not positive in implementing the fusion and consilience, in a form of disciplinary cross over to introduce practical knowledge into landscape designing. It has not been long since the effective correlation between road design and landscape and Kansei engineering has been implemented. Therefore, it is required to construct characteristic and charming SMART Highways designed with aesthetics and pleasantness by applying the methodology

which can utilize various amenity resources including scenery, design, history, culture and environment from the design phase, otherwise might damage natural scenery, eco-system and living environment.

This paper proposes a methodological process including site survey and analysis to typical classification of roadscape, development of scenic theme, and selection of landscape control points (LCP) and view target, in order to apply a design method which considers the high speed driving characteristics and emotional characteristics in roadscape design. The methodology will be able to be applied in the setting up the scenic theme, route and road alignment design, to construct pleasant and safe roads.



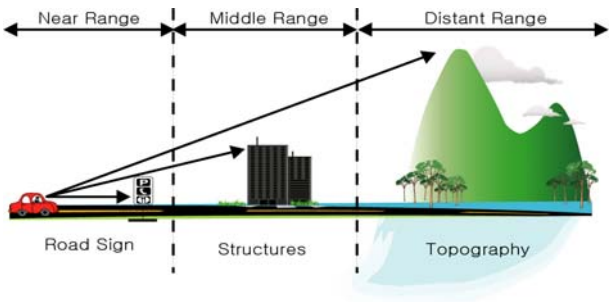
<Fig. 1> Flowchart of the Study

2. Driver's Visibility while driving

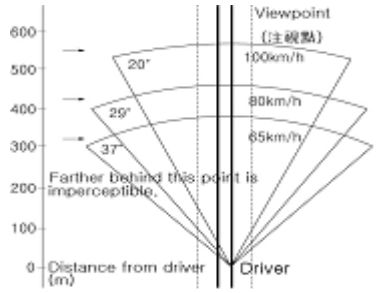
The visual distance, which is the distance from the point of view to the target, determines the visual size of the target together with the scale of the target. The visual distance, which usually is classified into near view, middle view and far view, is an important factor that forms the scenic impression of the target to the viewer (The structure of landscape, Docuchi, 1975).

In the classification of visual range, the near perspective area is about 300~400m range of distance where the viewer can catch the movements of individual leaves, branches and trunks. The medial perspective area is about 400m~3km range of distance where the viewer can catch the texture of arbores, but not in details. In this range, the viewer can recognize the shapes of buildings and their background areas. In distant perspective area, further 6km,

the viewer cannot discern individual tree or shape of arbores, but can grasp the topography by viewing the whole range.



<Fig. 2> Prospective characteristics by visual distance



<Fig. 3> Visual Size and focal distance based on Traveling speed (The structure of landscape,Docuchi, 1975)

Vehicle's traveling speed is the most important factor in the visual range while traveling. It is not possible to recognize the target if the traveling speed does not allow the minimal time required for visual perception. The driver's focal distance gets farther according to the increase of speed, which detailed scenery is meaningless on fast driving roads. In this case, simplified scenery will provide more meaning to drivers. In order to bring attention of drivers, the size of visual targets should be large enough to be recognizable from a distance. In other words, if the driving speed increases, drivers will get father perspective, and relatively the nearer scenery will be missed. Therefore, the distance of view in line has to be considered carefully while planning.

Driver's horizontal visual angle decreases as the driving speed increases. For example, the visual angle at 40km/h speed is about 100°, 65° at 72km/h speed, and 40° or under at 105km/h speed.

This decrease of visual angle, closed view, can cause the drowsiness to drivers. To bring attention and remove eye fatigue of drivers, scenic view must be provided at every appropriate intervals to give changes, while maintaining the overall context. In addition, as road views are perceived as sequential scenes in dynamic view, not in static, scenic view, the design should ensure the visual continuity considering the driving speed.

Measure of visual sensitivity on highway at increased design speed of 120km/h	1. Change in visual angle	Recognition decreases in far left/right range.	Applicable to road signages.
	2. Change in angle of elevation	Recognition decreases in higher elevation.	
	3. Change in readability	Focus on different angle cannot take long.	
	4. Change in openness	Increased of rejection to passing or crossing road structures.	Applicable to structures.

<Fig. 4> Changes in visual characteristics caused by increase of speed

3. Analysis on Scenic Resources

The survey and analysis of scenic resources are performed in the design phase of roadscape based on driver's emotional characteristic. These are important processes for developing the concept and idea of the roadscape. In this paper, driver's driving characteristics and visual perceptive characteristics at high speed driving are discussed and human factors on roads are concerned in order to create a pleasant road environment during landscape design.

3.1 Surveying Scenic Resources

The scope of scenic resource survey shall cover the range influenced by the development, the range influenced by the existing major targets regardless of the development and the range which can be zoned by visual restriction.

Scenic resource survey shall reflect the regional characteristics by observing rules, regulations and ordinances and the master plan for landscape and management plan of the local government. In addition, all the matters related with Aesthetic design shall be in compliance with and based on the applicable master plans and laws and regulations. Major scenic resources are the reference of the selection of scenic theme for roadscape design, and form the sequential views in and out of the highway by being considered in the route and road linear design.

The scope of survey includes 1,000m distance range which is a farther view, and the resources, especially the targets of prospect which are farther than 1,000m but have influence on the plan area should be included in the survey. Since, the boundaries of the targetive areas do not mean much in most of scenic plans, they are required to survey the neighboring areas which may have influence.

<Table 1> Classification of perspective range (Urbanscape Plan, S. B. Im, 2008)

Range	Distance	Recognition
Near Perspective Range	About 100m	Individual trees, road signs and structures
Medial Perspective Range	About 500m	Recognition by color and texture - buildings, etc.
Far Perspective Range	1,000m or farther	Forms skyline, background and topography

In scenic resource surveys, general conditions, natural and artificial environments of the plan region are included and the methods are classified into documentary study and onsite survey for both favorable and unfavorable resources. In order not to omit any major resource, the distribution and characteristics of the resources classified into several types should be examined.

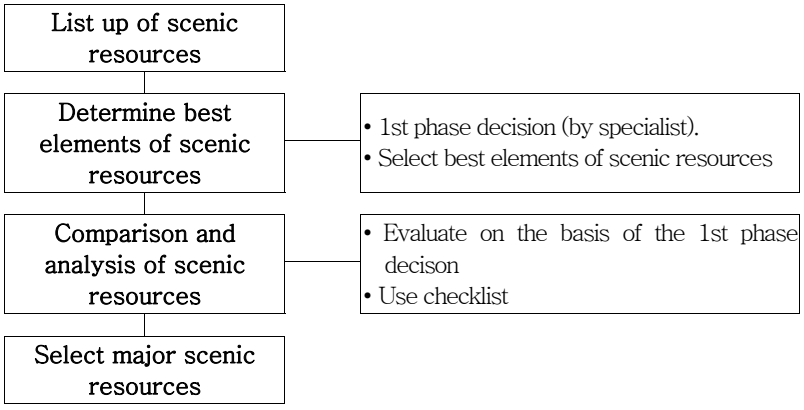
<Table 2> Classification of scenic resources

Classification		Scope of Survey
Natural Resources	Forest	Forests and hills which are the natural scenes of the hinterland
	Waterscape	Rivers, streams, lakes, etc.
Historic, Cultural resources	Traditional structures	Cultural assets designated by the authority
	Regional symbol	Traditional elements, those represent the village or region
Living Resources	Residential scenery	Residential and commercial views formed in the region
	Road and structures	Views formed by infrastructures, e.g., road, railroad, bridge, etc.
	Agricultural scenery	Farming spaces formed by compositions combination and harmony for space of production.

It should be noted that, not only the favorable scenic resources are indicated in the designs, but also the unfavorable resources, such as power transmission line, large slope or adjacent developed area are indicated.

3.2 Selecting major scenic resources

Select best items by using scenic resources and check lists, and select a major scenic resource through the comparison, analysis and evaluation after quantifying and applying weights by scenic types to evaluate scenic resources.



<Fig. 5> Procedure of Selecting major scenic resources

Extract major scenic resources through quantitative evaluation by applying weight, according to the experience, regional characteristics and target of the project. The resources shall be determined to be preserved or removed according to the quantitative evaluation result.

<Table 3> Standard of weighting scenic resources by type

Classification and Description			Weight	비고
Natural Scene	Forest	Topographical features and skyline of the region	1.0	
	Waterscape	Rivers, lakes, sea, etc., important for route planning	1.4	
Historical, Cultural Scene	Historical Resources	Scenic resources containing characterized historical assets, such as buildings, structures, houses, legend, characters, etc.	1.3	
	Cultural Resources	Scenic resources containing characterized cultural assets such as regional image, festival, event, etc.	1.3	
	Regional Symbol	Major landmark in the region which provides characteristical view	1.3	
Urban Scene	Residential Scenery	Characteristic view of residential facilities	1.0	
	Road and Structures	Characteristic view of the urban roads and structures (including bridge) having influence on the prospect	1.0	
Rural Scene	Agricultural Production Elements	Characteristic view of the productive elements, such as rice fields, farms, greenhouses, etc.	1.2	
	Rural Elements	Views having characteristic rural, farming scenes.	1.1	

Note 1). Classify the targetive resources by type and apply major resources with weights.

Note 2). Weights are based on various parameters (personal favorite, psychological factors, experience, climate, weather, and regional characteristics) and subject to change according to the site condition by specialist.

The scenic resources evaluation sheet which presents quantitative importance of the resources is an important data for reasonable routing plan of a Aesthetic road. This sheet is prepared with the resources presented in the scene status analysis diagram (visualized) according to evaluation standard.

<Table 4> Evaluation Sheet (Region C)

Classification		Weight	Evaluation Scale					Total
			Com-mon	Rather impor-tant	Import-ant	Very import-ant	Extremely important	
			1	2	3	4	5	
Natural Scene	Forest	1.0		○				2.0
	Waterscape	1.4			○			4.2
Historical, Cultural Scene	Regional Image	1.3					○	6.5
Urban Scene	Residential Scenery	1.0	○					1.0
	Roads and Structures	1.0	○					1.0
Rural Scene	Agricultural Scenery	1.2			○			3.6
Total								18.3

<Table 5> Evaluation Sheet by Region

Scenic Resource	Score	Remark
Region A	16.2	Good natural scenery
Region B	11.5	Good water-scape
Region C	**18.3**	**Very good historical/cultural views**

3.3 LCP and Target of View

In natural scenery, the LCPs (Landscape Control Points) generally are major roads, esplanades, points of concentrated use or points of superior view. An LCP may be a point, a line or an area.

In the beginning, the LCPs and target views are selected from the scenic resources, and the selected resources are comprehensively analyzed to derive scenic resource analysis diagram which presents the optimal LCPs and respective target views. The LCPs and target views are visualized in the same scale (1:5,000) as the road linear alignment plan.

Type			
View target	Individual structure, e.g., bridge	Mountains, hills	Rivers, lakes
Visibility Range Analysis	Highest point of the structure	Peak, 70% of top	Ordinary water level
Distance-based	Near: approx. 100m Middle: approx. 500m Far: 1,000m above	Near: approx. 100m Middle: approx. 500m Far: 1,000m above	Near: approx. 100m Middle: approx. 500m Far: 1,000m above
Orientation-based	4-directions (consider road axis)	4-directions (consider road axis)	4-directions (consider river axis, orthogonal axis
View Aesthetics	The point where the structure can be viewed overlapping good scenery.	The point where natural beauty can be viewed.	The point where good water-scape can be viewed.

<Fig. 6> Application of reference line and plane view

The points of intensive use or where good scenic resources can be viewed are selected as the LCPs, evenly from user-oriented and scenic resource-oriented view points. Select external LCPs as well as internal points, considering the major scenic targets visible from each LCP, near, middle and far perspective ranges, and the scene of the target site viewed from neighboring areas.

<Table 6> Selection standard of LCP by type and exemplary selection sheet

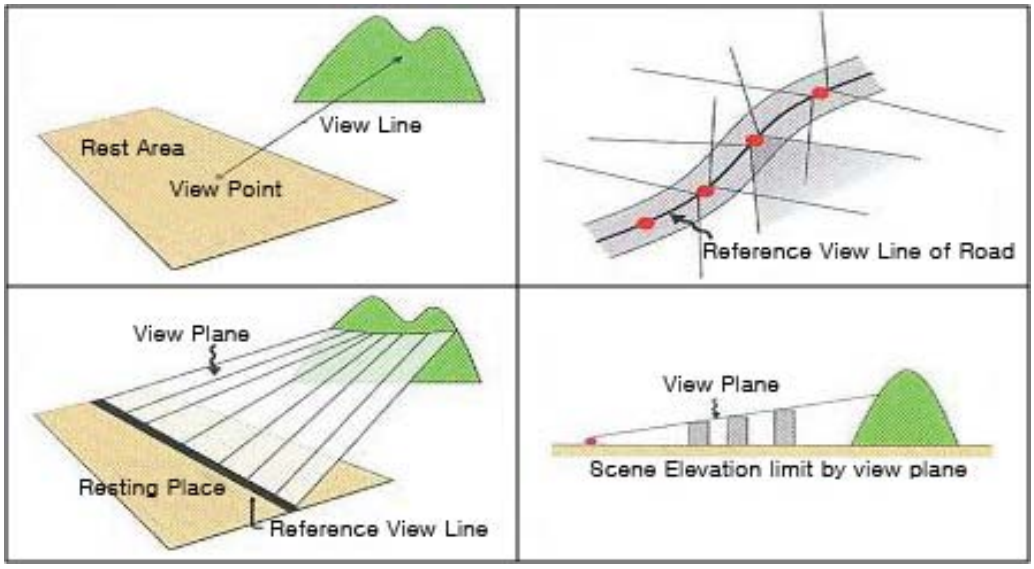
Classification		Selection Standard	Exemplary LCP
Classification by the central concept	Scenic resource oriented	· View point of good scenic resources	· Near major buildings and landmarks · Major points near cultural asset · Observation platform (mountain top, panorama) · View of entrance
	User oriented	· Points of intensive use	· Major roads and intersections · Parks an squares · Popular facilities (cultural, commercial assets, promenade, rivers)
Classification by view points	Internal LCP	· Major points in the plan area	· Major points in the plan area
	External LCP	· Major points near the plan area	· View of entrance · Major points in nearby roads
	Near/Middle /Far View	· Expected points of scenic changes in near/middle/far perspective range	· Distribute LCPs according to the distance from the scenic target
Classification by LCP utilization	Regulatory LCP	· Reference LCP set up to preserve good scenery	· Reference LCP for view preservation (strategic standard LCP)
	Forming-type LCP	· Reference LCP to form nice view in the future	· Reference LCP for scenic plan
	Control-type LCP	· Reference LCP set up to control bad scenery	· Reference LCP of scene monitoring for sustained management

Select the view targets primarily visible in the landscape plan. The view target area shall be selected according to the representativeness of the scene in the region. The selected best view shall be the landmarks, having high visual recognition to the users and residents, and seen by most people.

For roads, to analyze the visible range in a certain section, plot points on the center line of the road at fixed intervals, and the section which shows most number of the points can be defined as visually important area. Therefore, the section having many viewing frequencies should be managed in the aspect of landscaping.

In large areas without obstacle, such as rest stations, squares, or the terrace land on the river, LCP is difficult to be selected. In such areas, the reference view line can be a line

perpendicular to the line connecting the center of the area and the view target. This reference view line can be applied in the view plane planning to secure view of neighboring mountains or hill areas.



<Fig. 7> Utilization of reference view line and view plane (Urbanscape Plan, S. B. Im, 2008)

3.4 Route Plan Using Scenic Themes

Since the scenic theme defines the basic orientation of the landscape plan of highway, classify the type of the Aesthtic road according to the major scenic resources, set up the scenic theme according to the type of the Aesthtic road, and perform route, road line and major structure planning on the basis of the LCPs and basic image of the target views.

4. Conclusion

This study is aimed at developing an analysis methodology for the scenic resources which are the references of beautiful roads, adding pleasantness to roads whose major functionality was mobility. This paper proposes a methodology which supports survey and analysis of scenic resources, consideration of LCPs and target views, setting up of scenic theme, and the landscape planning which considers drivers' visibility in the process of road route and linear planing, ensuring pleasant driving and harmony with the environment. For this, the policy of scenic resource survey and analysis methods were set up to enable the designers to survey and analyze the scenic resources easily. In addition, the significance of the method is that it is a quantitative and concrete process.

This is a methodological study on the landscape planning based on the development of the survey, analysis and prediction methods of scenic resources. This paper presents a systematical process of roadscape planning from the survey and initial planning phase to design, evaluation, construction, and maintenance, which is expected to be applicable in the planning and evaluation of landscape of highways.

The recent trend of road design is in the transient phase from the traditional design concept focused on mobility and safety to scenic and environmental considerations. To meet such social and engineering needs in road design planning, this study may contribute to provide the highway users with pleasantness and safety by applying smart highway landscape planning technique considering driver's visual perceptive sense and driving characteristics.

Acknowledgment

This study was sponsored by the Construction Technology Innovation Program of the Ministry of Land, Transportation and Maritime Affairs (MLTM), managed by the SMART Highway Project Group. The author hereby expresses appreciation to hose related in the Program.

Reference

1. Handbook of Scenic Road Improvement Project, 2008, MLTM.
2. Final Report on the Study on the Development of Master Plan for the Construction of Scenic Roads, 2007, MLTM.
3. AesRoad 21 Road Landscape Improvement Technology Development Project, 2004, Korea Institute of Construction Technology (KICT).
4. A Study on the Policy for the Preservation of Excellent Scenic Areas by Type, 2001, KLTM.
5. Landscape Plan of Vehicle Roads, a translation for Japanese book, 1996, KICT.
6. Final Report on the Detail Planning Research of SMART Highway Project Group, 2008, Korea Expressway Corporation.
7. Principles of Highway Engineering, Shon Won-Pyo, Banseokgisul, 2006.
8. Urban Landscape Planning, Im Seung-Bin, Jipmundang, 2008.

9. Applicability of Kansei Engineering ti Civil Engineering, G. M, Nam, et al., Korea Society of Civil Engineers, 2005.
10. Development of Road Landscape Design Model Considering Drivers' Emotional Factors, a thesis for a doctorate Park Sang-Myeong,, Wongwang University, 2006.
11. A Study on the Recognition Evaluation of Road Geometry by Kansei Engineering, M. S. Park, G. M. Nam, et al., Korea Science Foundation Objective Basic Research, 2000.
12. Manual (Ⅰ)(Ⅱ) for Road Landscape Improvement, Road Landscape Research Group, Japan, 1988.
13. Road Design (道路のデザイン), 財団法人道路環境研究所, Japan, 2005.
14. 樋口忠彦, 景観の構造, 技報堂： Japan, 1975.